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PREPARATION AND PHYSICAL PROPERTIES OF REFRACTORY CARBIDES[1]

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About 120 persons from 45 scientific institutions of various cities of the Soviet Union took part in the seminar "Preparation, Thermodynamic and Other Physical Properties of Carbides of Refractory Metals, Silicon and Boron," organized by the Institute of Materials Science of the Academy of Sciences of the Ukranian SSR. The 42 reports delivered at the seminar dealt with problems involved in the preparation and pressing of carbides, study of the phase diagrams of carbide systems, and study of the electrical, thermal and thermodynamic properties of various refractory carbides.

The report of G. V. Samsonov exposed the scientific principles of the classification of carbides and recommended the use of the characteristic feature of the energy spectrum of electrons in the crystal lattices of carbides as a classification criterion for the refinement of the existing classification.

A number of reports presented the results of experimental work on the conditions of preparation of carbides, particularly carbides of silicon and titanium of high purity, carbides of rare earth elements, certain binary carbides having highly mechanical properties, and also certain cermets, i.e., alloys based on zirconium dioxide and carbides of zirconium, titanium and

*Numbers given in the margin indicate the pagination in the original foreign text.

[1]Seminar held in Kiev January 13-15, 1964.

niobium. Several reports were devoted to the results of a study of the phase diagrams of binary (Ti - C, Nb - C, etc.) and ternary systems. To indicate the labor-consuming nature of such investigations, it is sufficient to mention that in a study of the isothermal section (at 1450°) of the relatively simple ternary system Ti - V - C, the authors of this work, Ye. N. Yeremenko and L. A. Tret'yachenko, carried out an X-ray diffraction and metallographic study of over 200 alloys. Of unquestionable interest was also a series of other studies reported at the seminar, dealing with the reaction of carbides with refractory metals, the diffusion of carbon into metals, the study of equilibria between the nitrides of titanium, zirconium and hafnium with carbon, the diffusion welding of carbides to refractory metals, etc.

A large group of reports was devoted to the study of various physical properties of carbides at temperatures up to 2500°C, namely, the thermoemissive properties, thermal conductivity, electrical conductivity, Hall coefficient, thermo-emf, etc. In some of these studies, the properties were investigated as a function of the composition of the carbides in the region of homogeneity. It was found that the electrical resistance of NbC_x, ZrC_x and some other carbides increases with decreasing carbon content (as compared to stoichiometric carbides), whereas the thermal conductivity decreases. The Hall coefficient and the thermo-emf for TiC_x have negative values and their absolute value increases with rising content of combined carbon in the phase.

Particular attention should be given to the work dealing with the vaporization of carbides of zirconium, hafnium, niobium and other refractory metals. Researchers from Moscow, Leningrad and Kiev delivered reports on this subject. In the work of I. V. Golubtsov, V. N. Vlasov and others (Moscow State University imeni M. V. Lomonosov) and N. M. Karnaukhova (Physicotechnical Institute,

Academy of Sciences, USSR) use was made of the method of determining the rate of vaporization from the surface (Langmuir's method) involving the collection of the vaporization products on a collector and the determination of the quantity of these products by means of activation analysis. V. V. Fesenko and A. S Bolgar (IMSS AN USSR) used the differential method of determining the vaporization rate from the surface. The results obtained in these investigations are not in sufficient mutual agreement; as was noted in the discussion of these reports, this was due to the diverse composition of the specimens studied and certain deficiencies in the methods of investigation employed. Since the data on vaporization are some of the most important characteristics of refractory carbides which determine the possibility of their use at high temperatures, the desire to improve the coordination of such research has been expressed at the seminar.

Major interest was concentrated during the seminar on theoretical research /131 into the thermodynamics of carbides of variable composition. The heats of formation and free energies of formation of carbides as a function of composition in the regions of their homogeneity were discussed in the work of R. G. Avarbe, Yu. N. Vil'k and S. S. Nikol'skiy (GIPKh), while in the work of B. N. Oshcherin (LTI imini Lensovet) calculations of the characteristic Debye temperatures, heat capacities, and energies of atomization of carbides were made. Unfortunately, because of the fact that the literature contains very little reliable data on the thermodynamic properties of carbides (particularly carbides of variable composition), the conclusions drawn in the above-mentioned studies could not be compared with the experimental data. For this reason, the decisions adopted by the seminar note the necessity of a further expansion of experimental thermodynamic studies of carbides and other refractory compounds,

which would permit a more successful solution of the problems of application of refractory compounds as high-temperature structural materials (for example, heaters for high-temperature furnaces, etc.).